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MILTON WHITNEY, Chief.

IN COOPERATION WITH THE VIRGINIA AGRICULTURAL EXPERIMENT STATION,
ANDREW M. SOULE, DIRECTOR.

IMPROVEMENT OF VIRGINIA FIRE-CURED TOBACCO.

BY

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LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
Washington, D. C., May 16, 1907.

Sir: I have the honor to transmit herewith the manuscript of a report covering demonstration work carried on in cooperation with the Virginia Agricultural Experiment Station in an effort to improve the methods used in growing tobacco in the dark fire-cured tobacco districts of Virginia. This work covers a period of three years, and the report, entitled Improvement of Virginia Fire-Cured Tobacco, by George T. McNess and E. H. Mathewson, of the Bureau of Soils, and B. G. Anderson, of the Virginia Agricultural Experiment Station, embodies results and suggestions of much practical benefit to the growers.

In accordance with your suggestion, the report has been gone over carefully with Assistant Secretary Hays, who authorizes me to state that he concurs in my recommendation for its publication.

Respectfully,

Milton Whitney,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

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IMPROVEMENT OF VIRGINIA FIRE-CURED TOBACCO.

PART I. GENERAL DISCUSSION.

INTRODUCTION.

Virginia may justly be called the parent of the tobacco industry in this country, for the culture of tobacco was the principal occupation of the early colonists. Tobacco was first grown by the settlers in the historic town of Jamestown, in James City County, and the first exportation was made in 1612 by John Rolfe. At that time all of the tobacco, except what was used by the colonists, was exported to Europe, principally to England, that being the only market; and as the price was uniform, whether for sale or for a circulating medium, it was necessary to institute an inspection to compel uniformity of grades.

The original standard of the type was what is now termed the dark export type, and for a long series of years the laws regulating production, especially those passed by the colonial assembly of Virginia, requiring all of the product that failed to come up to the legal exactions as to quality and soundness to be destroyed, were rigidly executed. As the population of the colony increased new lands were cleared and the culture of tobacco spread rapidly, the tobacco field in a great many instances taking precedence over other crops; so much so that the subsistence of the colonists was seriously threatened. Laws were passed by the colonial legislature of Virginia that every person planting 1 acre of tobacco should also plant 2 acres of corn. Commercial fertilizers were not known at that time and, owing to the abundance of land, intensive farming was not practiced. The tobacco was planted on freshly cleared ground, and this soil, owing to its virgin fertility, always produced a tobacco of fine quality. Thus extensive areas in Virginia were early denuded of forest growth.

The principal method of harvesting tobacco was to pull the leaves from the stalk as they ripened and to hang them on cords to be cured in the sun and air. In later years it became the custom to split the stalk and hang the plant astride a stick, as is now generally practiced. Although the early planters for the most part cured their tobacco in

the sun and air, it was found that the tobacco kept better when the curing was conducted with the addition of small fires. At first small smothered fires of bark and rotten wood were used, but from year to year the amount of fire was increased until fires of sufficient heating capacity were built to dry the tobacco out in about three days. After the war of 1812 the demand for colored tobacco for export caused a change in the process of curing. After being cut and hung upon sticks the tobacco was either placed upon scaffolds in the sun to yellow and then housed, or it remained several days in the barn without fire until it had yellowed sufficiently to receive the heat without curing dark. A great many of the growers learned to cure a beautiful piebald, which commanded a high price in Richmond. Open wood fires constituted the only mode of curing by artificial heat until about the year 1828, when flues were first used in Virginia.

There are five distinct qualities of tobacco produced in Virginia—dark shipping; red and colored shipping; sun and air cured fillers; bright yellow wrappers, smokers, and fillers; and mahogany flue-cured manufacturing. These are severally characterized by peculiarities of color, quality, body, and flavor, the result of soil influence modified by curing and management.

It is of the dark shipping type raised south of the James River and east of the Blue Ridge that this publication treats. The dark shipping tobacco is generally grown on rich land and cured with open fires. England, Germany, France, Spain, Austria, and Italy take the bulk of this tobacco, although the high grades are used in this country for plug wrappers. Petersburg and Lynchburg are the most important markets for this type. In the vicinity of Petersburg the soil is mostly gray in color, becoming more red and containing a larger percentage of clay as the Blue Ridge is approached. The gray soil in the eastern end of the "dark belt" produces a coarser but thinner leaf than the red-clay lands and it is used to a considerable extent in domestic manufacture, but it is also used to supply a part of the varied export demands. The tobacco grown on the heavier soils is darker in color finer in texture and fiber, and of better body. This is used for both domestic manufacture and export, and from this section of the dark belt the finest grades of black wrappers are obtained, besides which a considerable proportion of the crop is especially adapted for the Austrian market.

Notwithstanding the great strides made in agricultural science during the past quarter of a century, the methods of cultivation, fertilization, and crop rotation now in use in the dark belt are essentially the same as they were a century ago. Why is it that other tobacco sections of the country have improved their methods of culture and fertilization, producing larger yields at less expense, even on soils less productive than the clay soils of the Piedmont region? This question has been

studied by the Bureau of Soils for the last three years, and it is believed from these investigations that there is an opportunity for the tobacco farmers of this district to make larger profits from their tobacco crops by using improved methods of culture and fertilization.

During the year 1904 the Bureau of Soils began work in Appomattox County, which after the first year was conducted in cooperation with the Virginia Agricultural Experiment Station, arrangements being made with Prof. Andrew M. Soule, director of the station, whereby the investigations could be extended to the mutual advantage of both the Bureau of Soils and the State of Virginia.

CLIMATE.

In climate Appomattox County is typical of the Piedmont region of Virginia. The climate is favorable to the growing of wheat, corn, oats, tobacco, fruit, and vegetables and to the raising of stock. The normal precipitation is about 43 inches. The precipitation is uniformly distributed throughout the year, but during the growing season crops sometimes suffer because of periods of drought. The altitude of the area is not quite sufficient for the best results in apple and peach growing, on account of the late frosts in the spring. On the higher points and on the small elevations away from the streams the best results are obtained. The trouble with the lower elevations is that the cold air settles in them and frosts are more likely to do damage when the trees are in bloom. There are no extensive areas in the county which are high enough to be above the "frost line."

The following tables show the normal monthly and annual temperature and precipitation at Lynchburg and Farmville, which are the Weather Bureau stations nearest to the location of the tobacco fields, for the years 1904, 1905, and 1906, during which the experiments were conducted:

Mean monthly and annual temperature for three years at Lynchburg and Farmville.

Month.	1904.		1905.		1906.	
	Lynchburg.	Farmville.	Lynchburg.	Farmville.	Lynchburg.	Farmville.
January	23.8	.....	32.2	35.2	42.0	40.0
February	33.0	31.0	30.1	29.9	38.4	35.4
March	46.6	48.8	48.8	48.3	41.2	39.4
April	52.1	52.8	56.8	57.6	58.6	.....
May	65.2	65.6	67.9	67.6	65.2	65.2
June	72.7	74.2	74.3	75.4	74.6	74.8
July	75.5	78.0	76.2	79.0	75.6	76.1
August	74.4	74.6	74.2	74.7	77.5	.....
September	63.9	67.0	69.9	.....	72.5	71.9
October	56.2	.....	56.8	.....	55.4	56.4
November	44.6	43.4	46.1	45.6	48.6	.....
December	35.0	33.8	39.1	36.0	40.6	.....
Year	51.8	.....	56.1	.....	57.5	.....

Monthly and annual precipitation for three years at Lynchburg and Farmville.

Month.	1904.		1905.		1906.	
	Lynchburg.	Farmville.	Lynchburg.	Farmville.	Lynchburg.	Farmville.
January	1.47	.....	3.11	2.44	4.08	2.57
February	1.91	2.80	2.47	1.70	1.14	.85
March	2.17	3.10	2.21	1.68	4.93	.....
April	.97	1.20	2.33	2.34	2.47	1.33
May	2.76	4.90	6.11	3.61	3.18	2.86
June	5.49	4.24	4.92	.....	3.21	.....
July	3.74	3.14	6.86	1.75	4.10	.....
August	2.70	2.70	6.21	2.15	4.84	10.69
September	1.47	.....	2.15	.....	2.34	.90
October	.40	.....	2.46	.....	7.15	7.98
November	.98	3.83	.45	.48	2.27	.80
December	2.81	1.60	6.32	.....	2.92	.....
Year	26.87	.....	45.60	.....	42.63	.....

The data given in the above tables partly represent the conditions as regards the temperature and rainfall during the period the work was in progress.

The following table shows the precipitation during the growing season of 1904, 1905, and 1906 upon the fields at Appomattox. It will be noticed that during July and August of 1905 and 1906 the rainfall was excessive, so much so that it caused the tobacco to speck, which caused a deterioration in the quality of the leaf.

Precipitation during growing season at Appomattox, Va.

Month.	1904.	1905.	1906.
June	2.48	2.20	4.98
July	3.00	6.05	2.68
August	3.24	4.98	7.34
September	3.30	2.86	2.52
Total	12.02	16.09	17.52

The weather conditions during the season of 1904 were, perhaps, about the average. June and July were droughty, while during August and September enough rain fell to keep the crops in good growing condition. In the growing season of 1905 June was a dry month, and, while the rainfall of 6 inches during July was favorable for the growth of the tobacco, less rainfall in August would have been more desirable. The season, on the whole, was more favorable for plant growth than that of the preceding year. In August of 1906 the climatic conditions were extremely unfavorable. A great number of cloudy days occurred during this month. This condition, together with the 7 inches of rain which fell during the month, caused considerable damage to the growing tobacco throughout the county.

SOILS.

Appomattox, the county seat of Appomattox County, is located 23 miles east of Lynchburg, on the Piedmont Plateau, in that geographical division of the State known as Middle Virginia. As viewed from the near-by mountains to the northward, it has the general appearance of an eroded plain, but in traveling across the county its surface is seen to be greatly eroded, hilly, and cut by the channels of many streams. The county is drained on the north by the James River and on the south by tributaries of the Staunton River. The divide between these two rivers is a ridge crossing the county from Concord to Pamplin City. The greater portion of the county is underlain by talcose and mica schists. The soil derived from the schists is principally the Cecil sandy loam, with occasional patches of Cecil clay, these two soils being the best adapted for the culture of heavy tobacco. Ninety-two per cent of the county is composed of these two soils. It is upon the Cecil clay soil that the cooperative experiments between the Bureau of Soils and the Virginia Experiment Station have been conducted.

CECIL CLAY.

The surface soil of the Cecil clay is a red loam or clay loam ranging in depth from 4 to 8 inches. The subsoil is a stiff tenacious clay to a depth of 3 feet or more, with the clay content usually increasing in the lower depths. There is considerable quartz or hornblende gneiss strewn over the surface and mixed with the soil, but these rock fragments do not occur in sufficient quantities to interfere seriously with cultivation. The Cecil clay in the present area occurs principally upon the slopes adjoining the larger streams, but it is also found upon the divide. Owing to its location it is rolling and in places rather hilly and broken, and for these reasons possesses good natural drainage. Unless the soil is kept in a good condition for retaining moisture, by deep plowing and by incorporating with it an abundance of organic matter, it is apt to be droughty. The brownish red loamy phase of this soil, locally known as "push land," is the loamy surface material washed from the higher elevations and consequently is deeper and more loamy than the typical Cecil clay.

This type of soil is regarded as the best for general farming and is especially adapted to the cultivation of heavy export tobacco, and to the production of an excellent quality of plug wrapper tobacco, which is used for domestic manufacture. The yields range from 500 to 1,000 pounds to the acre, although in the cooperative experiments a yield of 1,500 pounds to the acre has been obtained, under better methods of fertilization and cultivation. The average yield obtained by the farmer is about 700 pounds to the acre. Tobacco is followed by wheat with a

yield of 12 bushels to the acre. Wheat is followed by clover, and when a good stand is obtained the latter crop is very beneficial to the soil. Owing to the compactness of the soil there should be grown more cover crops, such as rye and cowpeas, which when plowed under improve the physical condition of the soil. Lime is also beneficial to this type.

The following table shows the texture of the soil and subsoil in the plats used in the present experiments:

Mechanical analyses of Cecil clay.

Locality.	Description.	Organic matter.	Fine gravel, 2 to 1 mm.	Coarse sand, 1 to 0.5 mm.	Medium sand, 0.5 to 0.25 mm.	Fine sand, 0.25 to 0.1 mm.	Very fine sand, 0.1 to 0.05 mm.	Silt, 0.05 to 0.005 mm.	Clay, 0.005 to 0 mm.
		P. ct.	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*	*P. ct.*
Appomattox, Va	Red clay loam, 0 to 8 inches.	.....	2.7	7.6	4.9	10.6	9.1	34.8	29.8
Do	Red clay, 8 to 36 inches	.....	.6	1.7	1.7	2.9	5.3	30.3	55.3
Experiment Farm	Red clay loam, 0 to 7 inches.	.....	.9	3.2	2.7	13.2	25.0	30.0	24.7
Do	Red clay (subsoil)	.....	.6	1.8	1.1	6.9	11.1	24.4	54.5

PART II. DEMONSTRATION WORK AT APPOMATTOX.

SEASON OF 1904.

Owing to the deterioration in both quality and yield per acre of the heavy fire-cured tobacco, the Bureau of Soils decided that it was advisable to extend its investigations to include this branch of the tobacco industry. The purpose was to determine by actual field work if it were possible, by introducing more intensive methods of culture, such as are used in some other tobacco districts, to improve the quality and yield of this type of tobacco, and to make its production more profitable. In the spring of 1904 a suitable location for conducting these experiments was decided upon, land on the farm of Mr. H. C. Babcock, 3½ miles northeast of Appomattox being selected. Arrangements were made with Mr. Babcock for the use of 5 acres of Cecil clay land for a series of years, together with the necessary curing barns, tobacco sticks, and plant-bed land.

In order to test the effect of variation in soil on the quality of tobacco, two fields were selected—one of 3 acres and the other of 2 acres, the soil of the latter being a little more loamy and darker in color than that of the 3-acre field. Prior to this the 2-acre field had been cropped with tobacco and wheat in rotation for several years and it was in a state of low productiveness. The soil of the 3-acre field is locally known as "mellow red land," and is somewhat "puffy," though possessing medium to good depth and friability, and owing to the

system under which it had been farmed it was also producing small crops. The year preceding the experiment (1903) it had been planted in corn, and yielded, with the aid of a small amount of commercial fertilizer, between 10 and 15 bushels to the acre. Prior to that it had lain out as an old discarded field for a number of years, being used occasionally as a pasture.

The experiment as planned was really complete on the 3-acre field. This field was divided into plats of 1 acre each, and the 2-acre field into similar plats. These latter were an exact duplication of two of the plats on the 3-acre field, except for the difference in soil. The odd plat on the 3-acre field was used as a check against the results obtained on the others. Taking into consideration the slight difference in soil, this duplication of plats was also decided upon in order to lessen the chances of failure which might occur from unforeseen conditions of soil or season. Results proved that this caution was advisable. Both fields were planted to tobacco in 1904 and 1905, but only the 3-acre field was planted to tobacco in 1906, the 2-acre field being in wheat to determine the effect of the fertilizer applied to the tobacco upon the succeeding crops in the rotation.

Both of the crops grown on the 2-acre field were abnormal and from the standpoint of the experiment of no real value. In 1904 great difficulty was experienced in obtaining a stand of plants on this field, owing to the unexpected presence in the soil of innumerable individuals of a so-called "wireworm" or root webworm (*Crambus caliginosellus*). In a day or two after setting out the tobacco several of these pests were found on each plant, riddling the stalk and eating out the pith, either destroying the plant at once or weakening it so it would eventually die. No remedy was found to kill the webworm, but it is believed that by keeping the soil cropped and not allowing the land to lie out and grow up in "stichneck," this pest can be overcome. On June 29 this field had been completely reset for the fourth time, and as the season for the ravages of the webworm was then over a good stand of plants was at last obtained, which started off well and made excellent growth until the end of the season. As this crop was planted fully a month after the best time for planting to obtain normal growth, it was not considered of experimental value as an illustration of average results.

In 1905 no trouble was experienced in obtaining a good stand, but, owing to the position of the field, the exceptionally heavy rains of the season washed it badly. This, together with a long-continued season of warm rainy weather occurring at a time when the tobacco plants were in such a tender, succulent condition and so vulnerable to plant diseases that they began to speck, affected both the quality and yield to such an extent as to make the result of no value from the standpoint of an experiment.

The crops grown upon the 3-acre field during 1904, 1905, and 1906, with no more than the usual seasonal vicissitudes, were quite normal, and the results are a demonstration of what it is reasonable to expect one year with another under circumstances such as obtained during these seasons. In discussing the results of the work it is to be understood that reference is made to the 3-acre field, except when otherwise stated.

The custom in most of the dark tobacco districts of Virginia, and particularly in the Appomattox locality, has been to apply to the tobacco crops about 400 pounds of a local fertilizer analyzing about 3 per cent ammonia, 8 per cent phosphoric acid, and 3 per cent potash—as the farmer terms it, "3–8–3 goods." The total cost of producing an acre of tobacco, charging labor at the prevailing rate of 75 cents a day, has been about $50. The yield under average conditions has been about 800 pounds to the acre, and at the average price of 7½ cents per pound would return to the farmer $60. Under these conditions the farmer received little more than enough to pay the cost of production, with no pay for the managing ability required, capital invested, or risk involved.

The Bureau of Soils and the Virginia Experiment Station both believe that much better results are possible by the introduction of a more intensive system in methods of cultivation and fertilization. The results of the experiments which are recorded in this bulletin furnish strong proof that this belief is well founded. Owing to the rapidly changing economic conditions throughout the South, and especially owing to the increasing scarcity and advancing prices of labor, some such radical change in the conduct of the tobacco industry in Virginia seems imperative if tobacco is to retain its commanding position as a money crop in the dark districts of the State.

FERTILIZATION.

To secure practical results as soon as possible and to leave the testing of untried formulas to some future time, the fertilizers used in a comparative test with that in local use were such as had been proved to be suited to the production of tobacco in other work of the Bureau.

On plat No. 1 of the 3-acre field 400 pounds of a standard 3–8–3 brand of fertilizer, such as is generally used by the farmers, were applied. On plat No. 2 and plat No 3 mixed formulas were applied, which gave to the acre very much larger quantities of the important ingredients and in proportions considerably changed from those in the brand of fertilizer used on plat No. 1. The cost of the materials used in the home mixture was greater, but not when measured by the amounts of ammonia, phosphoric acid, and potash actually applied. This can be

ascertained by figuring the cost per unit of these salts from the data given in the tables. The very large increase, both absolute and relative, in the amount of ammonia[a] furnished by the mixture will at once arrest the attention. The amount of potash furnished was also much greater, but it must be remembered that the soil was in an unproductive condition, having received no application of stable manure for several years; neither had leguminous crops been grown upon it for an indefinite period. On soils that have been well manured or on which repeated heavy crops of legumes have been grown, the need of heavy applications of ammoniates, in order to produce a good crop, will be greatly lessened. However, in this section of Virginia the supply of barnyard manure is limited as compared with the acreage planted, and crop rotation is not generally practiced on a very intensive plan. Tobacco is one of the high-priced crops, and usually responds readily to liberal fertilizing, and it will generally be found that with an increase in yield there will also be an improvement in the quality of the leaf and naturally a better price obtained. Thus it will be found that tobacco will pay well for the liberal use of fertilizers when low-priced crops like corn might not do so.

Composition and cost of the several fertilizers used in the Appomattox fields.

Material.	Formula No. 1 (factory-mixed).	Formula No. 2.				
		Ground fish.	Nitrate soda.	Bone meal.	Sulphate potash.	Total.
Guaranteed analysis:						
Ammonia (NH_3) ..... per cent..	3	10	19	4.5	.....	.....
Phosphoric acid (P_2O_5) ..... do....	9	7	.....	22	.....	.....
Potash (K_2O) ..... do....	3	.....	.....	.....	50	.....
Quantity applied per acre ..... pounds..	400	500	100	100	150	850
Equivalent quantity per acre of—						
Ammonia (NH_3) ..... do....	12	50	19	4.5	.....	73.5
Phosphoric acid (P_2O_5) ..... do....	36	35	.....	22	.....	57
Potash (K_2O) ..... do....	12	.....	.....	.....	75	75
Cost per ton delivered at Appomattox ... dollars..	25.00	34.50	50.50	30.00	50.50	.....
Cost of quantities used in experiment ..... do....	5.00	8.62	2.53	1.50	3.79	16.44
Cost of fertilizer constituents per pound:						
Ammonia (NH_3) ..... cents..	21.66	14.45	13.30	13.80	.....	.....
Phosphoric acid (P_2O_5) ..... do....	5.00	4.00	.....	4.00	.....	.....
Potash (K_2O) ..... do....	5.00	.....	.....	.....	5.05	.....
Cost of fertilizer constituents per acre:						
Ammonia (NH_3) ..... dollars..	2.60	7.22	2.53	.62	.....	10.37
Phosphoric acid (P_2O_5) ..... do....	1.80	1.40	.....	.88	.....	2.28
Potash (K_2O) ..... do....	.60	.....	.....	.....	3.79	3.79

[a] The term "ammonia" is used instead of "nitrogen," because it is the term in common use in Virginia and will perhaps be better understood.

Composition and cost of the several fertilizers used in the Appomattox fields—Continued.

Material.	Formula No. 1 (factory-mixed).	Formula No. 3.				
		Ground fish.	Nitrate soda.	Bone meal.	Sulphate potash.	Total.
Guaranteed analysis:						
Ammonia (NH_3) ..... per cent..	3	10	19	4.5	.....	.....
Phosphoric acid (P_2O_5) ..... do....	9	7	.....	22	.....	.....
Potash (K_2O) ..... do....	3	.....	.....	.....	50	.....
Quantity applied per acre ..... pounds..	400	1,200	150	100	250	1,700
Equivalent quantity per acre of—						
Ammonia (NH_3) ..... do....	12	120	28.5	4.5	.....	153
Phosphoric acid (P_2O_5) ..... do....	36	84	.....	22	.....	106
Potash (K_2O) ..... do....	12	.....	.....	.....	125	125
Cost per ton delivered at Appomattox ... dollars..	25.00	34.50	50.50	30.00	50.50	.....
Cost of quantities used in experiment ..... do....	5.00	20.70	3.79	1.50	6.31	32.30
Cost of fertilizer constituents per pound:						
Ammonia (NH_3) ..... cents..	21.66	14.45	13.30	13.80	.....	.....
Phosphoric acid (P_2O_5) ..... do....	5.00	4.00	.....	4.00	.....	.....
Potash (K_2O) ..... do....	5.00	.....	.....	.....	5.05	.....
Cost of fertilizer constituents per acre:						
Ammonia (NH_3) ..... dollars..	2.60	17.34	3.79	.62	.....	21.75
Phosphoric acid (P_2O_5) ..... do....	1.80	3.36	.....	.88	.....	4.24
Potash (K_2O) ..... do....	.60	.....	.....	.....	6.31	6.31

The three plats were fertilized each according to the above formulas, the same treatment being given the same plat in all three years. The 1904 crop was a late one to start, owing to unfavorable weather conditions in the spring, but during the season made a good growth. Marked differences could be noted between the three plats—differences that could be correlated with the varying amounts of fertilizers used, as ach plat was given the same amount and kind of cultivation.

HARVESTING AND CURING.

Harvesting was begun in September, the first cutting of ripe plants being made on the 22d of that month and the last cutting on October 4. Weather conditions were fairly good during the curing of the first cutting and a satisfactory cure was obtained; but after the second cutting conditions were unfavorable during the entire curing process, with the result that the colors were not as clear nor as solid as could be desired. One of the difficulties with late tobacco is the failure to obtain a good cure, owing to the cool, dry weather conditions so often encountered in the fall.

As is well known by those having experience in the handling of cigar types of tobacco, the fermenting process to which it is subjected, especially by the bulk method, has an important effect in completing the color changes in the leaf. Although the leaf may be uneven in color or even green before undergoing this process, after being fermented the tobacco is solid and even in color. This suggested trying the effect of the bulk method on the last curing, regulating the temperature so as to avoid drying the leaf.

DARK FIRE-CURED TOBACCO FERTILIZED WITH FORMULA NO. 1.

DARK FIRE-CURED TOBACCO FERTILIZED WITH FORMULA NO. 2.

A room adapted for this purpose was fitted with bulkheads and the tobacco packed in bulk.[a] The room was kept at a temperature of 90° F. whenever the tobacco was being handled and a temperature of 80° F. was maintained during the fermentation process. In fourteen days the temperature of the bulk had risen to 100° F. The tobacco was then taken down, well shaken, and rebulked. At the expiration of another ten days the temperature had again risen to 100° F. The tobacco was then taken off the bulk and assorted into the various commercial grades and prepared for the market. In cases where there is a large quantity of leaf to be handled there are doubtless instances where this process might be employed to good advantage, but for general practice by the farmers the Bureau and the Virginia station do not feel justified in recommending it. The practice of placing the tobacco down in small bulks in cool rooms and allowing it to lie for some days or even weeks without the development of perceptible heat will be of some assistance in evening the colors and will often improve the general appearance of the tobacco. This practice is to be recommended if the tobacco is not put down in too high "order," and in any case it should be examined frequently to see that no mold or other damage develops.

COST OF PRODUCTION AND RECEIPTS FROM SALE.

Although the results from the 1904 crop were considered favorable and encouraging, it was believed that the soils on which this crop grew had not reached, with this single year of intensive methods, its maximum state of productiveness.

The following expense account for 1904 shows in detail the amount of time used and the expenses incurred in the various operations incident to the experiment, also the cost of the fertilizer applied to the respective plats. The difference shown in the amount of time employed in some of the operations is due in a great measure to the number of plants grown on each plat. For instance, on plat No. 1, 4,500 plants were set, while on plat No. 3, 6,000 plants were set. The prices charged for the labor and the teams employed are at the prevailing local rates for farm help.

The following tables show a detailed account of the expenses incurred and the results obtained from the sale of the tobacco from the three plats:

[a] For exact directions as to the method of laying a bulk, see Bulletin No. 29, Bureau of Soils.

Expenses of the 1904 crop.

Item.	Labor required on—			Rate per hour.	Cost of labor and materials.		
	Plat No. 1.	Plat No. 2.	Plat No. 3.		Plat No. 1.	Plat No. 2.	Plat No. 3.
	Hours.	*Hours.*	*Hours.*	*Cents.*	*Dollars.*	*Dollars.*	*Dollars.*
Plowing, 1 horse, twice	12	12	12	17½	2.10	2.10	2.10
Harrowing, 2 horses	2	2	2	25	.50	.50	.50
Laying off rows, fertilizing, and bedding	8	8	8	17½	1.40	1.40	1.40
Mixing and applying fertilizers	3½	5	6	7½	.26	.38	.45
Fertilizer, delivered at farm					5.25	16.75	33.00
Making hills	8	10	10	7½	.60	.75	.75
Plants, 50 cents per 1,000					2.50	3.25	3.50
Setting crop	20	25	25	7½	1.50	1.88	1.88
Cultivating, four times	8½	8½	8½	17½	1.49	1.49	1.49
Hoeing, three times	60	60	60	7½	4.50	4.50	4.50
Applying nitrate of soda		3	3	7½		.22	.22
Topping, suckering, and worming	42	55	64	7½	3.15	4.13	4.80
Spraying, three times	6	7½	7½	7½	.45	.56	.56
Paris green, 1 pound per acre					.20	.20	.20
Cutting and scaffolding	25	32	37	7½	1.88	2.40	2.75
Hauling to barn (4 men and 2 horses)	3	3½	4	50	1.50	1.75	2.00
Regulating barn, firing, etc	20	25	30	7½	1.50	1.87	2.25
Taking down tobacco	5	7	8	7½	.38	.52	.60
Stripping and tying	40	60	60	7½	3.00	4.50	4.50
Bulking and rebulking twice	18	20	22	7½	1.35	1.50	1.65
Sorting and tying	61	92	115	7½	4.58	6.90	8.63
Loading and hauling to market					2.80	3.60	5.10
Total cost per acre					40.89	61.15	82.87

Yield of tobacco and receipts from the 1904 crop, sold at Lynchburg, April 28, 1905.

Plat No. 1:	
393 pounds lugs, at $5.70 per 100 pounds	$22.40
210 pounds short leaf, at $7.50 per 100 pounds	15.75
70 pounds long leaf, at $10.50 per 100 pounds	7.35
673 pounds.	45.50
Plat No. 2:	
335 pounds lugs, at $6.10 per 100 pounds	20.43
358 pounds short leaf, at $10.75 per 100 pounds	38.48
155 pounds long leaf, at $11.50 per 100 pounds	17.82
35 pounds wrappers, at $12.50 per 100 pounds	4.37
883 pounds.	81.10
Plat No. 3:	
376 pounds lugs, at $7 per 100 pounds	26.32
395 pounds short leaf, at $7.25 per 100 pounds	28.63
388 pounds long leaf, at $9.50 per 100 pounds	36.86
65 pounds short wrappers, at $10.75 per 100 pounds	6.98
100 pounds wrappers, at $12.50 per 100 pounds	12.50
1,324 pounds.	111.29

From the foregoing tables it will be seen that plat No. 1 yielded 673 pounds of tobacco, which was produced at a cost of $40.89 and sold at public auction on the Lynchburg market, on April 28, 1905, for $45.50, leaving a net profit of $4.61 per acre. Plat No. 2 produced 883 pounds at a cost of $61.15 and sold for $81.10, showing a net profit of $19.95 per acre; while plat No. 3 produced 1,324 pounds at a cost of $82.87 and sold for $111.29, showing a net profit of $28.42

per acre. A comparison of the data for plat No. 1, which was fertilized with a 3–8–3 mixture, such as used by the farmers, with plat No. 3, which was fertilized with the Bureau's mixture, shows an increase of $41.98 in cost of production for the latter, but at the same time there is an increase of $65.79 in the returns from the sale of the tobacco and a net profit of $28.42, while on the former plat the profit was only $4.61. It appears that the heavier application of fertilizer, provided it be composed of the proper ingredients mixed in the right proportions, will result in a larger yield of the better grades of tobacco, which more than repays the planter his original expenditure.

SEASON OF 1905.

In the fall of 1904 the stubble which was left from the previous crop of tobacco was plowed out with a two-horse plow, and the land harrowed and seeded down in rye as a winter cover crop. This was plowed under in the spring of 1905 in order to maintain or increase the humus supply and to improve the physical condition of the soil. When the rye had grown to the right height for turning under, the soil (Cecil clay) was too hard and dry to plow, and when it later reached the proper condition, the rye had grown too tall. The growth was so large on plats No. 2 and No. 3, and especially on plat No. 3, that it was deemed advisable to mow the rye and remove it before plowing. The condition of the rye demonstrated the marked difference in the after effect of the different fertilizers and indicated clearly the advantage of the heavier applications. In cutting the rye the mowing bar of the machine was set very high to leave a good stubble to turn under. On account of the number of tobacco roots which were raked up with the cured rye it was impossible to obtain an accurate measure of the quantity of rye, but as near as could be estimated plat No. 2 yielded 1,000 pounds, while plat No. 3 yielded 2,000 pounds. The growth of the rye on plat No. 1 was all plowed under, as it was not heavy enough to interfere with the preparation of the land.

The tobacco crop of 1905 was planted earlier than that of 1904 and the growth started much better and more uniformly. The climatic conditions were fairly favorable and the entire crop matured at the same time, so that at harvest it was gathered at one cutting. Plat No. 3 and a portion of plat No. 2 were cut on August 31 and September 1, the remainder of plat No. 2 being harvested on September 2 and plat No. 1 on September 8.

The climatic conditions were favorable for curing, the weather continuing warm and the moisture conditions excellent. No difficulty was experienced in obtaining a first-class cure. The yield from each plat showed an increase over the previous year, and, judging from the market returns, the quality seemed the same. The product of the

three plats was sold at Lynchburg by public auction on the same day and under the same market conditions.

The largest yield obtained in 1905 is adjudged to be due in a measure to better moisture conditions, to early transplanting, and to a healthy unchecked growth, and in part to the general improvement in the productiveness of the soil, following the continuance of the intensive methods employed.

The following tables give a detailed statement of the expenses incurred in the production of this crop and the returns from the sale of the tobacco from the three plats:

Cost of growing 1905 cover crop.

Item.	Labor required on—			Rate per hour.	Cost of labor and seed.		
	Plat 1.	Plat 2.	Plat 3.		Plat 1.	Plat 2.	Plat 3.
	Hours.	*Hours.*	*Hours.*	*Cents.*	*Dollars.*	*Dollars.*	*Dollars.*
Plowing out tobacco stubble	2½	2½	2½	25	0.62	0.62	0.62
Harrowing, 2 horses	2	2	2	25	.50	.50	.50
Sowing rye, 2-horse drill	1½	1½	1½	30	.45	.45	.45
Rye seed, 1¾ bushels per acre, at 90 cents					1.58	1.58	1.58
Mowing rye, 2-horse machine	1½	1½	1½	30	.45	.45	.45
Raking rye, 1 horse		1	1	20		.20	.20
Hauling, 2 horses and 3 men		1	2	40		.40	.80
Total cost of rye					3.60	4.20	4.60

Expenses of 1905 crop.

Item.	Labor required on—			Rate per hour.	Cost of labor and materials.		
	Plat No. 1.	Plat No. 2.	Plat No. 3.		Plat No. 1.	Plat No. 2.	Plat No. 3.
	Hours.	*Hours.*	*Hours.*	*Cents.*	*Dollars.*	*Dollars.*	*Dollars.*
Cost of fertilizer					5.25	16.75	33.00
Plowing, 2-horse plow	6	6	6	25	1.50	1.50	1.50
Harrowing, 2 horses	2	2	2	25	.50	.50	.50
Laying off rows and listing, 1-horse plow	10½	10½	10½	17½	1.84	1.84	1.84
Mixing and applying fertilizers	3	5	6	7½	.23	.38	.45
Making hills	9	10	10	7½	.68	.75	.75
Cost of plants (50 cents per 1,000)					2.50	3.00	3.25
Setting and resetting	18	20	21	7½	1.35	1.50	1.58
Bran for poison (20 cents per acre)					.20	.20	.20
Paris green (one-half pound per acre)					.09	.09	.09
Applying poison	5	5	5	7½	.38	.38	.38
Cultivating, six times	25	25	25	17½	4.38	4.38	4.38
Hoeing	38	20	20	7½	2.85	1.50	1.50
Topping and suckering	52	65	70	7½	3.90	4.88	5.25
Cutting and scaffolding	35	44	47	7½	2.63	3.30	3.53
Hauling to barn (2 horses and 5 men)	2½	3½	4	57½	1.44	2.01	2.30
Regulating barn and firing	16	21	24	7½	1.20	1.58	1.80
Taking down	6	8	9	7½	.45	.60	.68
Stripping, assorting, and tying	96	120	138	7½	7.20	9.00	10.35
Hauling to Lynchburg					3.42	5.20	6.65
Commission and selling charges					3.05	4.93	6.19
Total cost					45.04	64.27	86.17

Receipts from the 1905 crop sold at Lynchburg, January 21, 1906.

Plat No. 1:	
360 pounds lugs, at $5.10 per 100 pounds	$18.36
367 pounds short leaf, at $8.25 per 100 pounds	30.27
115 pounds long leaf, at $10 per 100 pounds	11.50
842 pounds.	60.13
Plat No. 2:	
345 pounds lugs, at $5.40 per 100 pounds	18.63
398 pounds short leaf, at $7.50 per 100 pounds	29.85
493 pounds long leaf, at $8.75 per 100 pounds	43.13
60 pounds wrappers, at $15 per 100 pounds	9.00
1,296 pounds.	100.61
Plat No. 3:	
327 pounds lugs, at $5.40 per 100 pounds	17.65
420 pounds short leaf, at $7.75 per 100 pounds	32.55
695 pounds long leaf, at $9.25 per 100 pounds	64.28
85 pounds wrappers, at $14.25 per 100 pounds	12.11
1,527 pounds.	126.59

Total gross returns from each plat in rye and tobacco.

No. 1—842 pounds tobacco	$60.13	
		$60.13
No. 2—1,296 pounds tobacco	100.61	
No. 2—1,000 pounds rye, at $8 per ton	4.00	
		104.61
No. 3—1,527 pounds tobacco	126.59	
No. 3—2,000 pounds rye, at $8 per ton	8.00	
		134.59

From the foregoing tables it will be seen that plat No. 1 yielded 842 pounds of tobacco, which was produced at a cost of $45.04 and sold at public auction on the Lynchburg market for $60.13, leaving a net profit of $15.09 per acre. Plat No. 2 produced 1,296 pounds of tobacco and 1,000 pounds of rye hay at a cost of $68.47, and the rye and tobacco together sold for $104.61, showing a net profit of $36.14 per acre; while plat No. 3 produced 1,527 pounds of tobacco and 2,000 pounds of rye hay at a cost of $90.77, and the rye and tobacco together sold for $134.59, showing a profit of $43.82. Ignoring the cost and proceeds of the rye, we find that plat No. 1 showed a profit of $15.09; plat No. 2, $36.34, and plat No. 3, $40.42 against the profits for the last crop (1904) of plat No. 1, $4.64; plat No. 2, $19.94; and plat No. 3, $28.41.

SEASON OF 1906.

Wheat was used as the winter cover crop following the tobacco grown in 1905, as it was thought wheat would not run up so early in the spring as rye. The wheat grew well, and, as in the previous year, the growth on plat No. 3 was much larger than on the other plats.

The entire growth was plowed under early in May. The amount of vegetable matter plowed under on plats Nos. 2 and 3 was several times greater than on plat No. 1. This should give plats Nos. 2 and 3 considerable advantage over plat No. 1 in the matter of permanent soil improvement and should show plainly in subsequent crops of the rotation.

In plowing the field in preparation for the 1906 crop, one-half of each plat was plowed in the usual manner with a 2-horse turn plow to a depth of about 6 inches, while the remaining half was plowed in a similar manner but was also subsoiled (see Pl. IV) to an additional depth of from 6 to 10 inches. The season of 1906 was an extremely wet one, and there was no time during the growing period when the crop lacked moisture in the least. With these conditions there was no time during the growth of the crop that the slightest difference could be observed between the crop on the subsoiled land and on that not subsoiled. Had the season been droughty or even normal there might have been a marked difference. The entire crop grew well up to the middle of August and gave promise of a heavy yield and good quality. From that time on to harvest, there was protracted, wet, muggy weather, with no sun for several days at a time, which began to affect the quality and yield of the crop and, in common with nearly all other tobacco in the vicinity, the leaves began to speck badly. The resulting damage placed the bulk of the tobacco in the lug grade.

It is worth noting, however, that although the excessive wet and dull weather ruined the quality and yield of the tobacco, yet the plats which received the heavier applications of fertilizer did not speck more than the lighter fertilized plat, while the tendency of the lower leaves to yellow was less on the heavily fertilized plats than on the lighter fertilized one, showing that the larger amounts of fertilizer were beneficial to the plants even under the adverse climatic conditions.

Expenses of 1906 cover crop.

Item.	Labor required on—			Rate per hour.	Cost of labor and seed on—		
	Plat 1.	Plat 2.	Plat 3.		Plat 1.	Plat 2.	Plat 3.
	Hours.	*Hours.*	*Hours.*	*Cents.*	*Dollars.*	*Dollars.*	*Dollars.*
Plowing out stubble, 2 horses	3	3	3	25	0.75	0.75	0.75
Harrowing, 2 horses	2	2	2	50	.50	.50	.50
Cost of seed wheat, 1½ bushels					1.20	1.20	1.20
Sowing wheat, 2-horse drill	1½	1½	1½	30	.45	.45	.45
Total cost					2.90	2.90	2.90

Expenses of 1906 tobacco crop.

Item.	Labor required on—			Rate per hour.	Cost of labor and materials.		
	Plat No. 1.	Plat No. 2.	Plat No. 3.		Plat No. 1.	Plat No. 2.	Plat No. 3.
	Hours.	*Hours.*	*Hours.*	*Cents.*	*Dollars.*	*Dollars.*	*Dollars.*
Plowing land, 2 horses	6	6	6	25	1.50	1.50	1.50
Harrowing, 2 horses	3	3	3	25	.75	.75	.75
Cost of fertilizers					5.25	16.75	33.00
Laying off rows	9	10½	10½	17½	1.58	1.84	1.84
Mixing and applying fertilizer	3	5½	6	7½	.23	.41	.45
Marking hills	12	14	15	7½	.90	1.05	1.13
Cost of plants					2.00	2.40	2.60
Setting and resetting	16	20½	21	7½	1.20	1.54	1.58
Cultivating, five times	19	19	19	17½	3.33	3.33	3.33
Hoeing	22	22½	22½	7½	1.65	1.69	1.69
Topping, suckering, and worming	49	64	69	7½	3.68	4.80	5.18
Cutting and scaffolding	24	34	41	7½	1.80	2.55	3.08
Hauling to barn	3	5	6	47½	1.43	2.38	2.85
Firing and regulating barn	9	17	20	7½	.68	1.28	1.50
Taking down	4½	8½	11	7½	.34	.64	.83
Stripping and assorting	70	99	110	7½	5.25	7.43	8.25
Hauling to market					2.64	4.61	6.52
Commission and selling charges					1.92	3.30	4.51
Cost of cover crop					2.90	2.90	2.90
Total cost					39.03	60.15	83.49

Prices obtained for the 1906 crop at Lynchburg, February 27, 1907.

Plat No. 1:	
172 pounds common lugs, at $4.70 per 100 pounds	$8.08
285 pounds good lugs, at $7 per 100 pounds	19.95
72 pounds leaf, at $8.50 per 100 pounds	6.12
529 pounds.	34.15
Plat No. 2:	
368 pounds common lugs, at $5 per 100 pounds	18.40
477 pounds good lugs, at $7.25 per 100 pounds	34.58
77 pounds leaf, at $9 per 100 pounds	6.93
922 pounds.	59.91
Plat No. 3:	
530 pounds common lugs, at $5 per 100 pounds	26.50
700 pounds good lugs, at $7.50 per 100 pounds	52.50
75 pounds leaf, at $8.50 per 100 pounds	6.37
1,305 pounds.	85.37

From the foregoing tables it will be seen that plat No. 1 yielded 529 pounds of tobacco, which was produced at a cost of $39.03 and sold at Lynchburg at public auction for $34.15, showing a loss of $4.88; plat No. 2 produced 920 pounds of tobacco, at a cost of $60.15, and was sold for $59.91, showing a loss of 24 cents; while plat No. 3 produced 1,305 pounds of tobacco, at a cost of $83.49, and sold on the market for $85.37, showing a profit of $1.88. These poor results are due entirely to the unfavorable weather conditions during the latter part of the growing season, although the proportionate increase in the various plats, due to the effect of better methods of fertilizing and cultivation, shows as well as during normal seasons.

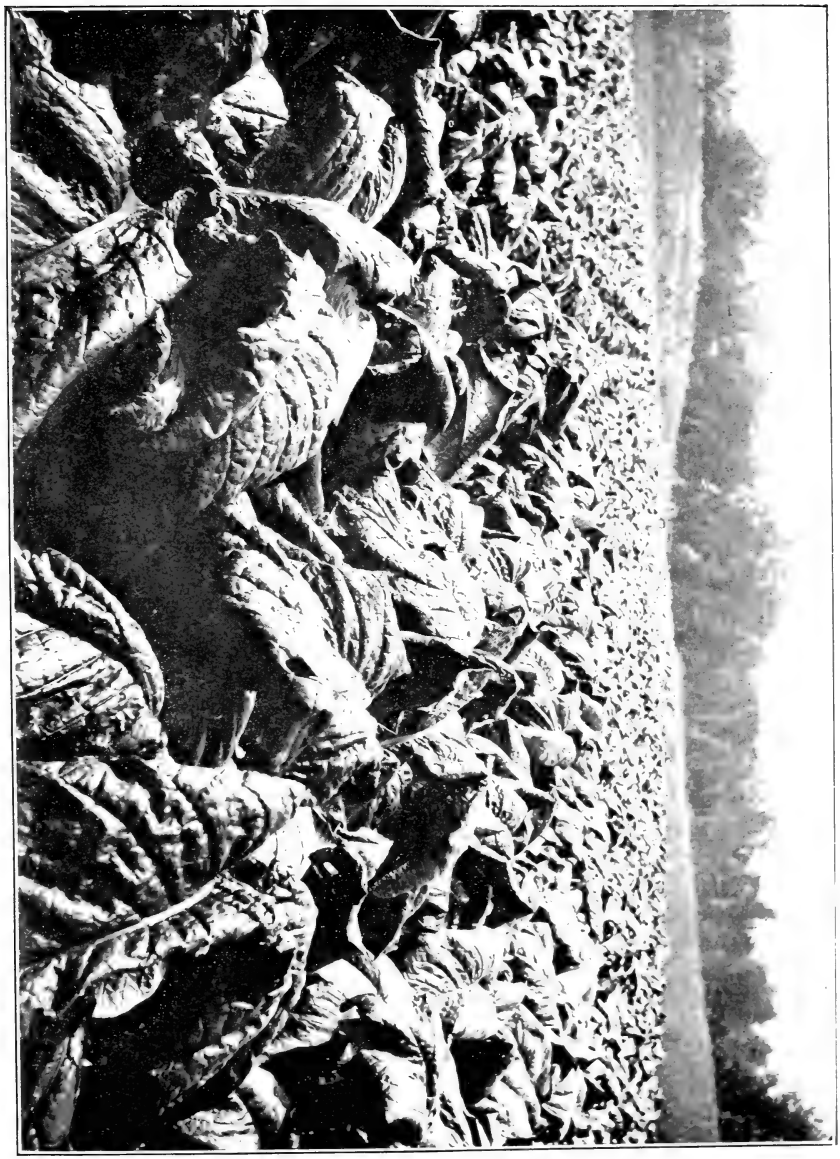
As a result of these three years of field experiment the Bureau of Soils and the Virginia Experiment Station feel justified in asserting that under proper conditions it will be of financial benefit to the farmers in the dark belt of Virginia to use fertilizers much more liberally on their tobacco than they have been accustomed to do. It is of course necessary to discriminate in order to make high fertilizing pay. A soil suitable for growing a fairly good quality of tobacco should be chosen. It should possess reasonably good depth and mellowness so as to be easily tilled and have a proper water-holding capacity. Fertilizers can not be expected to make up for shortcomings of the soil in these regards. Without proper moisture and friability in a soil it is impossible for the plant to get the full benefits from the fertilizer applied either in large or small quantities. Good cultivation and handling are also necessary to make a success of a tobacco crop.

PART III. METHODS OF CULTIVATING, CURING, AND HANDLING.

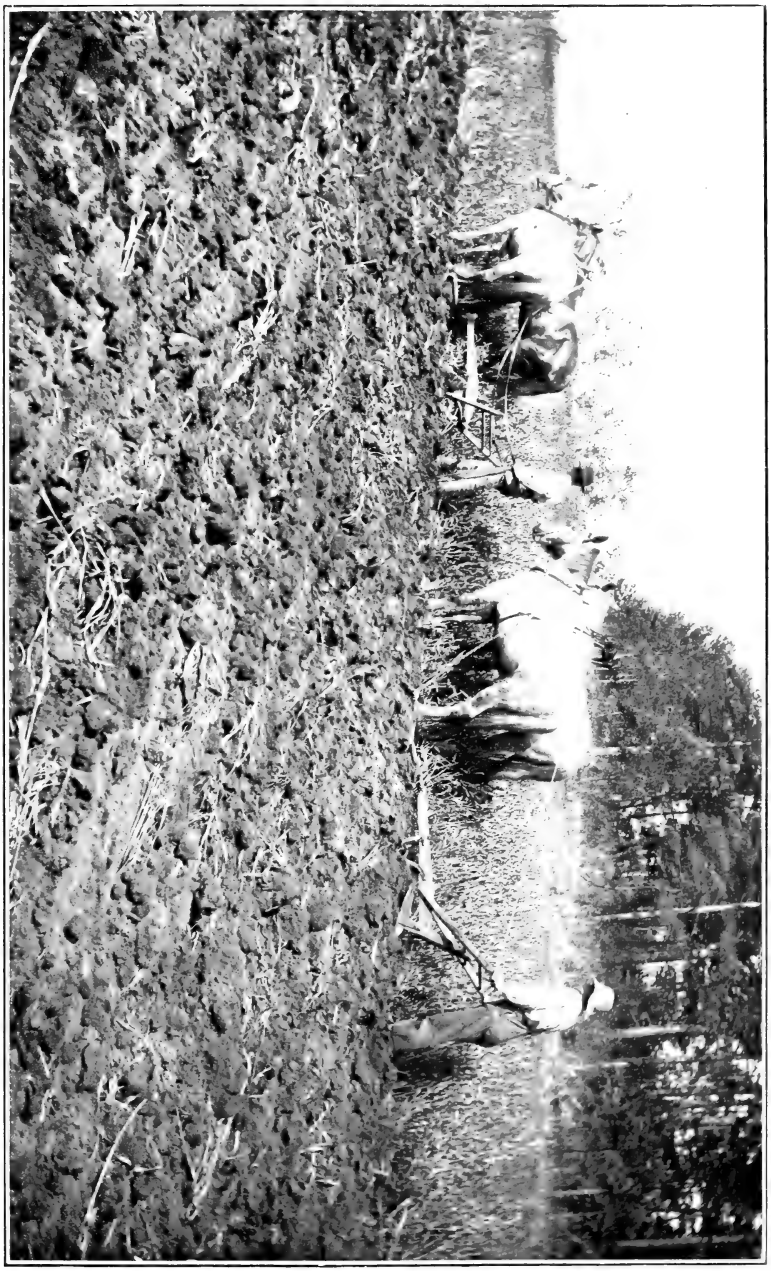
SEED BED.

The custom of going annually into the woods and clearing and burning a given area of land for a plant bed is still followed in Virginia. This work is usually performed and the seed sown during the winter months, at a time when the other farm work is not pressing. In former years it was considered necessary to select a piece of land bordering a small stream, which is usually both rich and moist. At the present time, however, not so much attention is being paid to such location, and desirable land for this purpose is often found on the higher levels. The prime consideration in selecting a suitable locality for the seed bed is to see that the soil is loamy and mellow; that it will not bake during a drought, and that it will absorb the rain without becoming mucky. The soil may be safely judged by the forest growth, the presence of oak, hickory, dogwood, etc., being usually considered a strong indication of good plant-bed land. The slope of the land should receive some attention, both as regards the tendency to wash from excessive rains and its probable effects on the earliness of the plants. A southern or western exposure is the most desirable.

If possible the wood should be stacked long enough before burning to become seasoned. A mixture of dry and green wood is more effective than either green or seasoned wood alone, as a steady moderate heat is more desirable than excessive heat. From 3 to 4 cords of wood with a plentiful supply of brush will usually be found sufficient to burn 100 square yards of land. After the brush and leaves are cleared off the land long poles are placed upon the bed about 5 feet apart to serve as skids on which to slide the fires. A layer of brush and wood is placed along the upper side and fires



DARK FIRE-CURED TOBACCO FERTILIZED WITH FORMULA NO. 3.



PLOWING UNDER WHEAT AND SUBSOILING.

started at frequent intervals. After the fires have burned in one place long enough to dry out the soil to a depth of 3 inches the burning wood should be pulled along the skids to a new place on this bed. This operation is repeated until the entire surface of the bed has been burned. With moderate fires it will take from one-half to three-quarters of an hour between "pulls" to burn a place sufficiently.

For two reasons it is not desirable to burn a bed when it is wet. One is that it will take considerable more burning to dry out this extra moisture and it may also do harm to the physical condition of the soil. Whenever possible the bed should be worked up and then seeded down immediately after burning. There is no other time that the soil will work into such good tilth. Most of the ashes and coals should be raked off. It will be found advantageous in preparing the soil to plow it several times in different directions with a shovel cultivator plow. Remove all the small roots and small stumps and cut off the large ones low enough so as not to interfere with stretching the cloth over the bed. Before sowing the bed, rake it off with a fine-toothed rake.

The fertilizer applied should not contain any potash, as the ashes that are left upon the bed will supply enough. The custom in these experiments has been to sow the seed in acid phosphate, about 25 pounds to 100 square yards, using from 1 to 2 tablespoonfuls of seed[a] for this amount of bed. Top dressing of hen, hog, or horse manure and nitrate of soda will also be found valuable. If horse manure free from grass can be obtained, it will serve both as an effective mulch and fertilizer. If suitable manure is not available for the purpose, fine straw scattered over the bed will serve as a good mulch; but of course it would have no value as a manure.

For protection against dry weather in the spring, this mulching of the bed is considered important. Beds so mulched will rarely need artificial watering and will stay moist and the plants continue to grow when other beds are dry and hard and the plants at a standstill. The manure or mulch should be applied some time before the plants come up, and it is also advisable to apply broadcast from 15 to 20 pounds of nitrate of soda to each 100 square yards of bed at this time. In the middle section of Piedmont Virginia, plants usually begin to appear the very last of March. The cheesecloth covering should be stretched over the bed before this time. Under normal conditions nothing more need be done to the bed until the plants are large enough to set out, unless the stand of plants is too thick and heavy or weeds appear in the bed. In this case the plants should be thinned out or the bed weeded.

[a] If the seed is clean, 1 tablespoonful is sufficient; but if there is considerable chaff and dust in it, 2 tablespoonfuls will be advisable.

As a rule, about 10,000 plants can safely be counted on from each 100 square yards of bed. The cost of production varies considerably according to the convenience of the wood supply for burning the bed, the variation in the amount of labor necessary to prepare the soil, and the favorableness of the growing season. Fifty cents a thousand would be a conservative estimate of the cost of growing plants one year with another.

PREPARATION OF THE FIELD.

The success of a crop of tobacco is often made or marred by the carefulness or carelessness of the preparation which is given the field before the crop is set out. No other general field crop will pay better for painstaking foresight in this regard than tobacco. If a crop rotation is followed, the crop preceding tobacco should be one which will add a fair amount of vegetable matter to the soil and permit of fall or winter plowing. It is also very important that the preceding crop shall leave the field as free as possible from insects, especially the dreaded root webworm, or so-called "wireworm" (*Crambus* sp.). Considerable headway can be made by the use of poisons in combating cutworms and some other insects affecting tobacco, but when the field becomes infested with root webworms a partial failure is generally assured in spite of anything that may be done. The worm has been found to be particularly troublesome in fields where much ironweed, a variety of Vernonia shrub, has grown previously, and this weed should not be allowed to grow after August 15 on a field intended for tobacco the following year. If it should be found impossible to keep this weed down, it should never be plowed under, but should be burnt off or mowed down and then burnt. In this way thousands of eggs of this insect will be destroyed.

For the heavy tobaccos of this section of Virginia there is not a crop better than the cowpea for tobacco to succeed. It is a leguminous crop that, through the aid of nodules on its roots, can add to the soil's store of ammonia, subtracting it (nitrogen) from the air. It also adds vegetable matter to the soil and its hay makes a first-class stock food, besides permitting fall or winter plowing. At Appomattox no other available crop was found which left the field so free from insect pests. The moths of the root webworms do not seem, according to the experience of the writers, to like the vine as a place for depositing their eggs. Therefore the use of the cowpea is strongly recommended whenever practicable as a crop to precede this heavy, dark type of tobacco.

The tobacco field should be deeply and thoroughly plowed. When plowed in the fall or winter, it should be deepened a little each year until the top soil is at least 8 inches deep. Winter plowing, aside from the benefit to the physical condition incident to repeated freezing and thawing, places the field in a condition to be readily put in order

for transplanting at an early date. Land not plowed in the winter often gets hard and dry in the spring, so that it is impossible to place it in good condition until it is too late to obtain the best results from the crop. It is a matter of experience that early crops are usually the best and most economical to produce. Therefore winter plowing is important as assuring an early crop.

In the dark tobacco districts of Virginia the greater portion of the crop is set out between May 15 and June 10, with the heaviest setting, if the climatic conditions are favorable, during the closing days of May. This, from our experiment, is never too soon, and it would be a great advantage to the farmers if they planted their crops as soon after May 15 as possible. If this were practiced, they would then have a good opportunity to perfect their stand before it is too late, and all of the plants would have a chance to mature properly.

DISTANCE OF PLANTING.

There is considerable difference of opinion among tobacco growers as to the number of plants which it is most profitable to set to the acre. No invariable rule is possible, as the ideal number varies with the conditions of soil and season. From 3,600 to 5,000 to the acre will perhaps express the limits within which most crops are planted. The usual practice is to make the rows 3½ feet apart and set the plants 3 feet apart in the row. A crop set at this distance will give 4,200 plants to the acre. It is probable that a large portion of the crop in the dark district is set with a less number of plants.

Experience and the experiments of several of the experiment stations go to show that the thinner plantings, other conditions being equal, will give a thicker and larger leaf and one that will cure up with a clearer color and better luster than where the plants stand closer together. Thicker plantings, on the other hand, will normally produce larger yields to the acre and the tobacco will be finer in texture and fiber.

The aim of the grower should be to strike the medium for the best average profit. It is, of course, true that there is a counterbalancing relation between the thickness of setting plants and the height to which the plants may be topped. The Bureau and the experiment station in their experiment have grown as high as 6,000 plants to the acre on plat No. 3, and judging from the sales that number was not beyond the limits of profitable returns. With the adoption of a more intensive system of cultivation on richer soils, it is their opinion that it will be found profitable to plant closer than is now the custom. It would appear conservative to suggest that at least 5,000 plants can be grown to the acre on soils that are in a reasonably good state of fertility. This number will be secured by making the rows 3½ feet apart and setting the plants 2½ feet apart in the row.

METHOD OF APPLYING FERTILIZER.

As before stated, it is the custom in the neighborhood of Appomattox to apply 400 pounds of fertilizer to the acre on the tobacco crop. This is applied almost exclusively by dropping a small handful in the furrows directly at the spot where the plant is to be set or by drilling it along the whole length of the row. Only a few farmers, judging from the above practice, seem to believe in broadcasting. When used in the larger quantities, as on plat No. 3, there would probably be many advocates of the broadcast method for at least a part of the fertilizer. In the absence of reliable experimental data we can not express decided opinions. It is not probable that the difference between the two methods would be large. For the sake of uniformity the fertilizer was drilled in upon all three plats in the experiment. In order to secure an even distribution of each of the ingredients of the home mixture, the fish was distributed in the furrows separately, and the other ingredients, after being carefully mixed, were also distributed in the furrow. A double-shovel plow was then run through the furrow, mixing the fertilizer with the soil and insuring at the same time a deep bed of loose soil directly under the plant. A small bed was made by a one-horse turn plow upon this furrow. This made a bed of loose soil in which to set the plants, and the furrows left at each side made certain that no water would stand directly around the plant in the event of heavy rains.

The so-called hills were made by striking through the bed with a hoe at the place indicated for the plant to about the normal level of the field. After making sure that the spot was free from trash or other obstructions that might interfere with the setting of the plant, a pat was made with the hoe, which completed the hill. A man will "cut off" in this way about 6,000 hills in a day if the field is reasonably free from trash and in a condition of good tilth. Variations of this method might be desirable or necessary according to the condition of the field.

SETTING THE PLANTS.

The aim at setting time is to have the plants grow off quickly and uniformly. A regular start in the growth of the plants is more important than many farmers seem to realize. There is a saving of labor all through, and it is possible to cultivate much more effectively if the crop maintains a uniform state of development. The ideal condition would be to have the crop sufficiently uniform to justify cutting clean as you go at harvest time. It would be the most economical way of handling and best for the quality of the tobacco.

In drawing plants from the bed care should be taken to have them uniform in size and hardness. They should not be bruised or allowed to lie around and curl up. When transplanted, care should be taken

that the earth is pressed firm around the roots at the bottom of the hole as well as at the top. It is very important in setting a plant that the head should be just at or slightly above the level of the ground.

It is, of course, necessary to take advantage of such planting seasons as come, but hot weather, moderate precipitation, with several days of cloudiness and little wind are the conditions most favorable to the newly transplanted plants. Cold winds and heavy rains are very unfavorable. About the third day after transplanting, a good idea may be obtained by the grower as to which plants will probably live. If the season in which the plants were set was a good one, there will still be left a good supply of moisture in the soil, and it is then the time to make an effort to perfect the stand of plants. Select the very strongest plants in the seed bed and reset the doubtful hills, pouring around each plant about a cupful of water. When the water has settled down, draw a little dry soil around the plant to keep the moist soil from baking and forming a clod about the roots. If great care is exercised in setting on the third day, the new plants will start growing at once and the entire field will be uniform.

Of course, if the soil is full of worms, especially the wireworm, an even start is out of the question. If this worm is found attacking practically every plant, as is sometimes the case, the grower might as well give up the field for tobacco that year, unless he chooses to wait until the last of June before resetting the field, at which time the worm disappears, but the chances would be less for a profitable crop from such late setting.

CONTROLLING INSECT PESTS.[a]

Cutworms.—Some headway was made in fighting the cutworms, which were present in considerable numbers, by using a mixture of Paris green and corn meal or wheat middlings and sifting a small quantity of this mixture on each hill either before or after the plant was set. The worms come to the surface when the soil is moist and eat this mixture. Whenever heavy rains washed the poison away the application was repeated. This mixture was also used in killing the bud worm and is best applied by shaking it over the plant. A tin can holding a quart or more with holes punched in the bottom and a handle made of stiff wire was found a convenient arrangement for applying the poison.

Hornworm.—The greatest pests of tobacco last season in Virginia were the hornworms. They made their appearance in two main broods. The first of these appeared during the latter part of June and the first part of July; the second early in August, remaining from

[a] For descriptions and full directions for the control of the insect pests of tobacco see Farmers' Bulletin No. 120, by L. O. Howard, Bureau of Entomology, U. S. Department of Agriculture.

that time until frost. The August brood was by far the more troublesome. Many farmers pay but slight attention to the June brood, the tobacco being in many cases so small that the leaves which they mutilate could be primed off at topping time. If the tobacco is forward, however, the worms will do as much harm as at any other time, and they must be kept off. Spraying with Paris green at the standard rate of 1 pound of Paris green and 1 pound of lime to 125 gallons of water was found effective. The mixture was kept well agitated during application, as the Paris green settles and the last part coming from the tank might be so strong as to damage the tobacco. The tobacco is not easily damaged by Paris green at the stage of its growth when the first crop of worms are present, and if care be taken not to get the settled solution on the leaves very little risk is taken.

For combating the hornworm in August the use of Paris green is of very doubtful expediency. In these experiments and from the experience of the farmers it has been demonstrated that the use of Paris green in the later stages of the growth of this type of tobacco is attended by great danger of burning the leaf, if applied in sufficient strength to kill the worms. Hand picking is therefore the great reliance of the Virginia growers. An effort should be made to check the worms when they are small, as at that stage of their growth the damage done by them is less, and they will usually be found near the damaged portion of the leaf upon which they are feeding. After they get larger they travel from one plant to another and easily elude very close searching.

It is the habit of the moth of the hornworm to spend its days in seclusion, but at dusk it flies over the tobacco fields, depositing its eggs on the underside of the leaves of the plant. Many of the moths were poisoned by the old-time remedy of putting a few drops of sweetened cobalt solution in the flowers of neighboring jimson weeds or in artificial flowers made for the purpose and set up on stakes about the field.

The natural lessening of the worm damage and of the labor necessary in catching the worms is one of the several reasons why early planted tobacco is likely to be more profitable than late planted tobacco. If the crop is ready for harvest by the last of August the tobacco is only liable to damage from the hornworm for a short period of time, whereas if the tobacco is set late and not ready for harvest until the latter part of September or the beginning of October the worms have a longer period in which to cause damage.

CULTIVATION.

The practice of many farmers in the dark district of Virginia is to cultivate the crop twice with a double-shovel plow and then for a last cultivation to lay the crop by with a turning plow by throwing four furrows to the row, two on each side. A period of two or three

weeks usually elapses between these cultivations. The crop is generally hand hoed twice. As opposed to this practice of infrequent deep cultivation, both the Bureau and the experiment station believe in the advantage to be gained by frequent shallow cultivation. About a week or ten days after the crop has been transplanted to the field the first cultivation should take place, as at that time the roots have not spread out into the soil and it has very likely become considerably packed in the middle of the rows, owing to heavy rains which may have occurred and to the considerable tramping which it has received when wet incident to the operations of setting, fighting cutworms, etc. At this time, therefore, a thorough deep breaking out of the middles of the rows seems desirable, and for this purpose on the stiff, red clay soils of Piedmont Virginia there is perhaps no better implement than the double-shovel plow with narrow blades run three times in a row.

This has been the practice in these experiments and has given satisfactory results. After this the roots of the plants will begin to spread

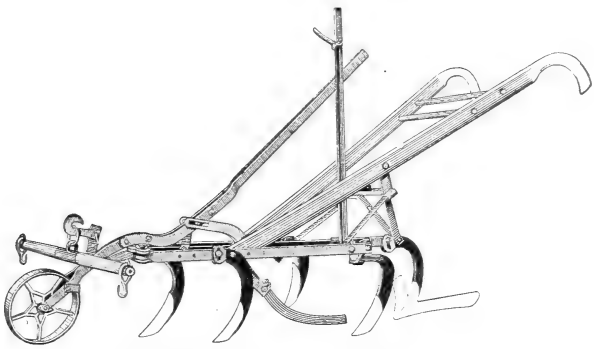


FIG. 1.—Cultivator used in the Appomattox fields.

into the rows and only shallow cultivation should be practiced. For this purpose a five-toothed cultivator of the familiar type (see fig. 1), with an 18-inch sweep on the rear stock and with depth-regulating attachment was used in the Appomattox fields. The crop was regularly cultivated each week during its growth. The idea of using a turning plow to form a high bed to each row or of repeatedly hilling up each plant with a hoe still has a good number of advocates, but it is probably being practiced less and less each year. Its exponents argue that there will be fewer lugs on the crop that is hilled and that it is easier to worm and sucker when walking in the furrows. Neither the Bureau nor the experiment station believes in the practice and it is certainly more expensive than simply passing through the row once or twice with a cultivator. In droughty weather the moisture supply is not so well retained as by the more level system of cultivation; besides the tearing up of the root system incident to the use of the

turning plow is wrong both in theory and in practice. If a rain occurs soon after the operation and settles the soil around the roots, the evil effect may not be so serious, but if droughty weather prevails the greatest harm to the growing crop is done.

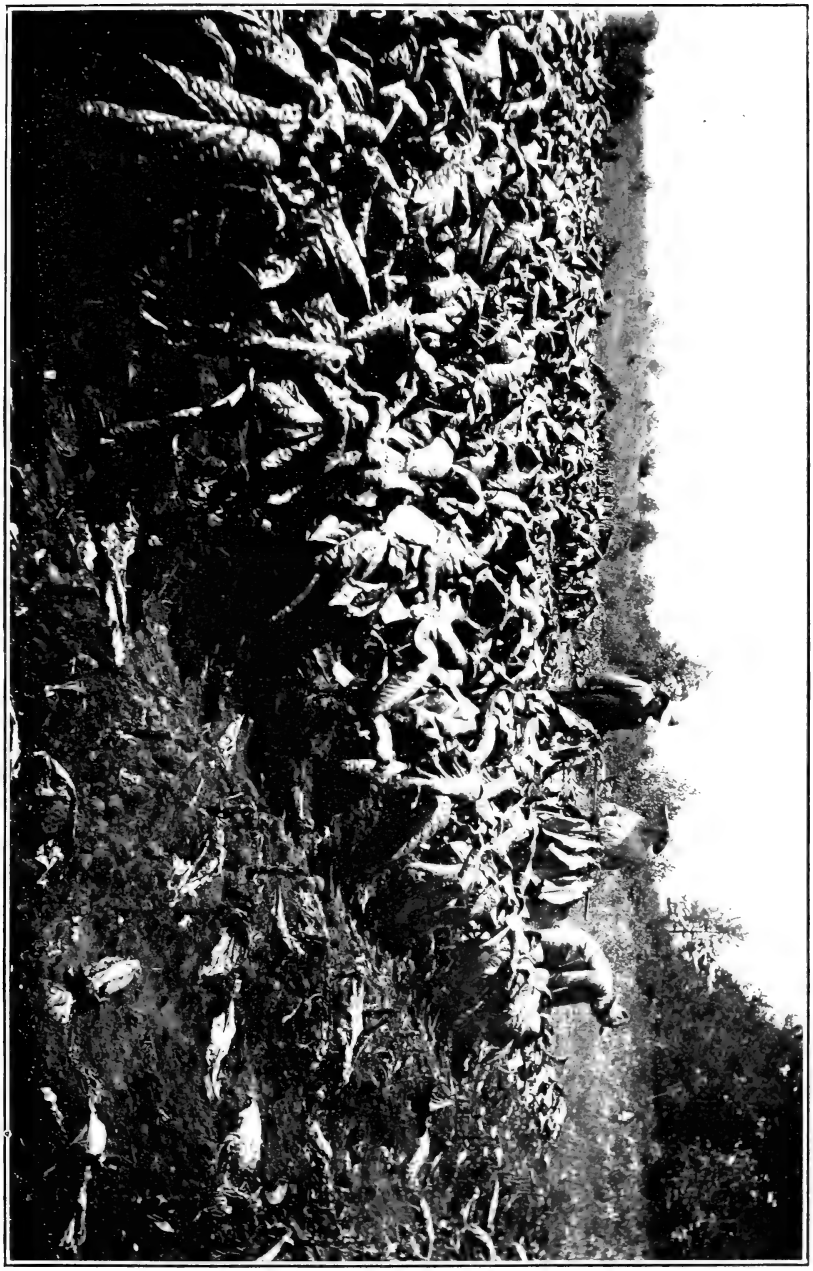
The increasing tendency of the plant to make lugs where level cultivation is practiced is perhaps indisputable in theory, but in practice we find the difference very slight and more than compensated for by the advantages enumerated. It is not to be understood that perfectly level cultivation is advised. The cultivator with the sweep attachment will draw a little soil to the plant each time it is used, and the field will finally be left with a gently undulating surface, sufficient to prevent water from standing around the plant in the event of heavy rains.

The first crop of tobacco grown at Appomattox was hand hoed twice and a portion of it three times, owing to the dry weather, depredation of the wireworm, and the countless number of vines and sassafras bushes that attempted to take possession of the soil. The succeeding crops were hoed only once, owing to the improved condition of the soil and also to the fact that very little resetting was necessary, and that consequently the crop started uniformly. In order to obtain the best results in cultivating, it is necessary that the plants should be set in line on the row so that the implement will place the soil uniformly around each plant.

TOPPING AND SUCKERING.

After a period of eight or nine weeks from the time of transplanting, some of the plants will normally begin to show signs of budding out. The topping season is now on hand. The aim here is to have the crop mature in a uniform condition, to improve the quality of the leaf produced, and to obtain as large a yield as possible. Experience and judgment are necessary in this important operation, although the greatest yield would be obtained by leaving on all the leaves and merely plucking out the bud as soon as it could be distinguished and by keeping off all the suckers. This is, in fact, all that is done in most of the types of cigar tobacco, but for the tobacco under consideration the leaves would be too small, and consequently lacking the body and toughness required by the demands of the trade.

The leaves that grow on the middle of the stalk naturally have the quality most desired. In order to improve still further the quality of these middle leaves there has developed the custom of priming off several of the bottom leaves and of breaking out several of the top leaves along with the bud in its undeveloped stage, so that all the nourishment is concentrated in less than half the leaves that would naturally grow on the stalk. About eight or ten leaves are usually left to mature, although the number left varies with the conditions. Primarily the number of leaves that should be left on a plant depends



METHOD OF HARVESTING DARK TOBACCO.

SCAFFOLDING AND HAULING DARK TOBACCO.

upon the thrift and vigor of its growth. If it is topped too low, the yield will be unnecessarily sacrificed and the leaves remaining will be coarse and overgrown, besides being more liable to damage by the weather or in the handling.

For the Austrian trade, which demands the largest leaf, there is very little to be gained by having the cured leaf more than 24 inches long, while for plug wrappers 20 inches would be more satisfactory. The aim of the grower should be to force the growth of the selected leaves while the plant is still young and vigorous. It is best, therefore, to break the top of the plant out just as soon as it gets above the number of leaves which are to remain. This will usually be some little time before the bud would appear. As an aid to topping to a certain number, as it is often desired to do, in giving instructions to field hands it is perhaps worth remembering that the leaves of tobacco are so arranged on the stalk that after the bottom leaves are primed off, the ninth leaf will be directly over the bottom one and if it be broken out with the top the plant can be topped to eight leaves without counting.

The time that it takes a plant to mature after topping depends somewhat on the number of leaves which are left. In order to bring as many plants as possible to a uniform state of ripeness at one time, it is customary to top to more leaves at first and then to fewer at subsequent toppings until the desired number are left. In these experiments, on plat No. 3, where the growth was very vigorous, the first toppings were made at about twelve leaves to the plant, and then down to seven or eight, leaving the field at the last topping with an average of ten leaves to the plant, while plat No. 2 averaged nine leaves to the plant, and plat No. 1 seven leaves.

Suckers will begin to appear from the axis of the leaves soon after the plant is topped. The first suckers will appear near the top of the plant and so on downward as the upper ones are broken off. Two sets of suckers will usually grow on the plant, but it will be necessary to go over the field five or six times, as they will grow upon the plants at different times. The whole object of topping is defeated if the suckers are allowed to grow, and they should not be longer than 2 inches before they are removed. The field should be gone over at least once a week, and in the experiment it was found more satisfactory to sucker the crop every five days, as the suckers being smaller could be broken out easier and faster than if allowed to grow larger.

HARVESTING.

From ninety to one hundred days after transplanting and about thirty-five days after topping the tobacco will usually be ready to harvest. Certain signs of ripeness accompany this maturity of the plant.

Their recognition is largely a matter of experience and judgment. The leaves for some time have been graining up and the appearance of the field has not the intensely green color which it had for two weeks after topping. The suckers have ceased to grow with their usual vigor. The edges of the leaf have turned a little yellow and begun to fold under a little all around. The leaf is thick, heavy, and brittle, and if it be pinched up between the thumb and finger it will crack open. These signs are unmistakable to the experienced grower. It is a fine question to know just when the entire crop is in the most favorable condition for cutting, in order to secure the best results in quality and yield. If it should stand too long in the field, it will deteriorate in weight, elasticity, and soundness. If, on the other hand, it is cut too soon, it will be sound but will be lacking in body and weight, and in the curing process it will not yellow so readily and the final color will be dull in hue instead of being clear and lustrous.

It is not always possible to choose, but when possible it is best not to cut tobacco until three or four days after a heavy rain, as the gum which accumulates on the leaf in dry weather and which helps its appearance and quality when curing is washed off by the rain, and if possible should be given time to accumulate again before cutting.

Harvesting by splitting the stalk down from the top to within 2 or 3 inches of the bottom and cutting off just below the bottom leaf and straddling the split stalk over a stick is the common practice. (See Plate V.) There are some localities where many of the farmers cut the plant down and allow it to wilt on the ground and then spear it upon the stick. Both methods have their advantages according to circumstances and labor. The splitting of the stalk hastens the curing process by allowing a more ready escape of the moisture from the stalk. This is undoubtedly an advantage. The sticks used throughout Virginia are all split by hand from pine timber. They are made 4½ feet long, so as to fit the distance between the tier poles in the curing barn, which are generally 4 feet apart. The method of procedure at harvest is of course varied some to meet the individual ideas of the farmers and according to the conditions of labor attending each case. The general method, however, is as follows: The sticks are first dropped through the field every fourth row, thick enough to take the tobacco that is to be cut for four rows. Two men with sharp knives will each spear the stalk and cut the plants from two rows and hang them at once on the stick which the third man is holding in the row between them. (See Plate V.) The laborer holding the stick should keep careful watch of the number of plants put on the stick and lay it carefully on the ground when full. The tips or tails of the tobacco should be turned away from the sun when there is danger of sunburn and toward the sun to make the tobacco wilt better when there is no such danger. From six to ten plants are usually placed upon a stick,

depending upon the size and condition of the plants and to a certain extent upon the climatic conditions which are to be expected during the curing process.

It is economy to place as many plants upon the stick as can be handled without damage. Eight plants to the stick are about the usual number. When the sun is high and hot it will not take many minutes for the tobacco to sunburn, and it is best to turn the stick of tobacco to prevent this damage. After wilting, the tobacco should be hung on a scaffold in the field (see Plate VI) or hauled to the barn (see

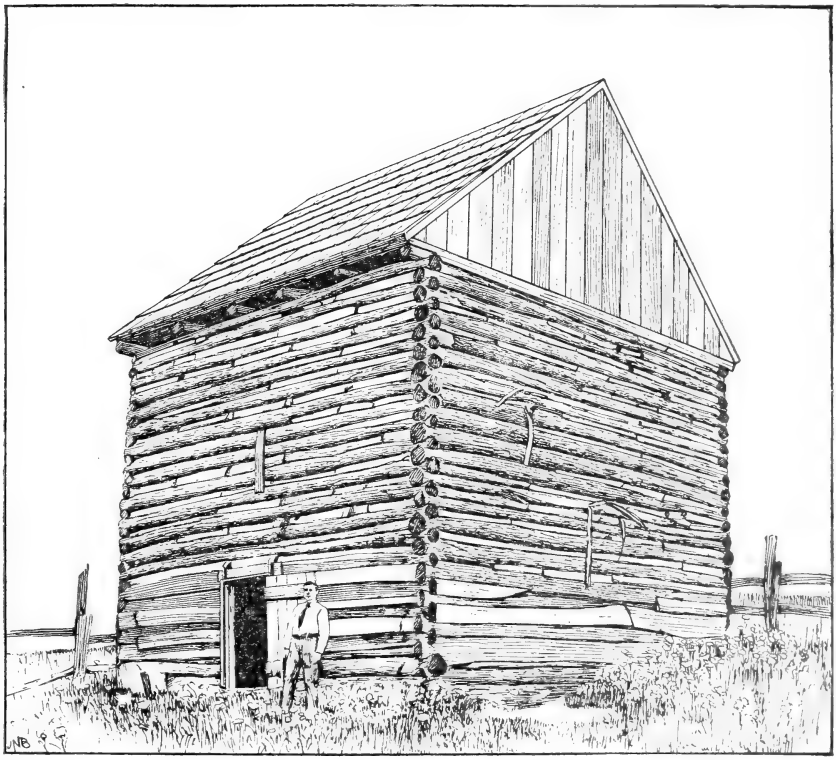


FIG. 2.—Curing barn for dark fire-cured tobacco.

fig. 2). If the labor conditions are favorable, there is no cheaper and in some cases no better way of handling tobacco than to haul it to the barn as fast as it wilts. There are, however, many instances when much is to be gained by first scaffolding in the field. The tobacco becomes so thoroughly wilted and sapped by staying several days on the scaffold with the hot sun shining upon the butts that the sticks may be spaced more closely in the barn without danger of house burn or pole sweat. There is thus a material saving of barn room. Another important gain by scaffolding is that when the labor force is

short the tobacco is removed from the hills in a much shorter period of time, thus insuring it from damage by hail, frost, etc.

To secure a uniform cure, it is important that the tobacco placed in the barn should be cut as nearly at the same time as practicable. Not over two or three days should be consumed, and it would be better if the barn could be filled in one day. In some instances it is probable that the tobacco may have to remain on the scaffold for several days after it is cut; therefore it should not be crowded on the scaffold, but sufficient space should be left between the sticks, so that in the event of rain the air and sun can penetrate and quickly dry out the tobacco. Otherwise the plants would "strut" with the moisture held between the leaves and the tobacco might become damaged. Owing to the scarcity of labor in Appomattox County, all of the tobacco in these experiments was placed upon a scaffold before being taken to the curing barn.

CURING.

At curing time we find one of the strongest arguments in favor of reasonably early planted tobacco. It is a difficult matter to obtain a satisfactory cure in cool, dry weather, such as often prevails in Virginia after the month of September is well advanced. In such weather it is hard to control the moisture and temperature conditions. It must be borne in mind that curing tobacco is entirely a different process from merely drying the leaf. Heat alone will dry tobacco, but in curing it is necessary to maintain an adequate amount of moisture. The changes which occur in the leaf while it is curing are mainly chemical in their nature and can not take place when it is merely dried, so that if the leaf becomes dry before the color changes are produced it will be found extremely difficult to bring them about afterwards even by a return of the right conditions of moisture.

This is where the trouble is experienced in curing a barn of late-set tobacco. It is apt to dry instead of to cure. The cool temperature at which the tobacco dries is unfavorable to the chemical changes that take place in the leaf to develop the desirable colors, and, unless used judiciously, if artificial heat is employed the conditions are not improved, because the addition of this heat is apt to exhaust the moisture and the result will be worse than if no heat is used. The yellowing stage is the first step in the curing process. The change to yellow is caused by a breaking down of the green chlorophyl granules during the first few days after the plant is cut. The riper the tobacco the more quickly will this change take place. Therefore to yellow uniformly, the plants should be cut as nearly as possible at a uniform stage of ripeness. This change in the leaf is favored and hastened by gentle warmth, moderate moisture, and darkness.

It is not customary to use artificial heat in yellowing this type of tobacco, especially with early cut tobacco. In cool weather this

change in the leaf may be favored by hauling the tobacco to the barn in the middle of the day and crowding it closely together in the barn, which will retain the heat and conserve the moisture. The barn should be kept closed, so as to keep out the light and cold air, maintaining a temperature of about 90° F. When crowded together on the poles in this manner, it must be closely watched, especially if the weather should turn moist and warm. Tobacco usually can not be left in this condition more than a few days. After the tobacco yellows it must be regulated in the barn, giving enough space between each stick to allow a free circulation of air, especially when helped by the building of small wood fires. The distance to be left between the sticks is a matter for judgment in each particular case, depending upon the nature of the barn and the expected climatic conditions. The next change that takes place in the leaf is from the yellow to the brown stage, and for this purpose artificial heat is used. This is also a chemical change and is due to certain oxidizing enzymes upon the chromogen compounds within the leaf.[a] Moderate warmth and the presence of sufficient moisture to keep the leaf in a soft, pliable condition until the change is completely effected in any given part of the leaf is essential.

The first fires built under the tobacco should be very small to avoid danger of premature drying of the tips of any of the leaves not yet fully yellowed. This is called "coddling the tails" by the farmers. The temperature should not be raised above 95° F. or 100° F. at this first firing, and should be maintained only long enough to dry out the surplus moisture and start the tips of the leaves already well yellowed to turn brown. A few hours at this time will generally be sufficient.

Unless the weather continues very moist it will not be necessary to fire the barn for several days; but at the expiration of that time fires should again be placed in the barn. This process should be repeated every few days until all the gum has disappeared from the leaf and the tips of the leaves have begun to take on the brown color. After these conditions have been obtained a somewhat higher temperature may be used safely if the moisture supply is sufficient to prevent the drying of the leaf before the color changes have taken place. It will not usually be found desirable to allow the temperature to rise above 125° F. for any length of time, as more tobacco has become damaged by too much than too little heat. It is the experience of old growers that tobacco cured with little heat will retain its oil and luster better and will be easier to order than when cured with more heat. After the barn has been fired three or four times in the way mentioned, the leaf will probably be pretty well cured, and will require no further attention until it is desired to take the tobacco down, perhaps several weeks later. In the event, however, of protracted warm, damp periods, it will be found necessary to examine the tobacco, especially

[a] See Report No. 65, Bureau of Soils, by Oscar Loew.

in the middle of the barn, and if musty stems are found and white begins to accumulate upon the midrib, moderate fires may be continued long enough to dry the tobacco thoroughly and prevent the spread of any damage.

In curing tobacco by fire it is better to make several small fires than a few large ones. The average-size barn in Virginia is about 20 feet square, and it is customary to build in this space about 20 small fires of hard wood, either oak or hickory. The color which a crop of tobacco will cure depends to a great extent upon the nature of the soil upon which it was grown. It is possible, however, by managing the barn to cure tobacco either light or dark in color. As a general principle, to cure tobacco light it should be spread thinly in the barn and enough fires used to cause a quick cure without drying the leaf too rapidly. To darken or blacken tobacco, the principle is to delay the cure and permit the tobacco to approach the pole-sweat condition, and not to dry off the excessive moisture faster than is necessary to prevent actual damage. Hang the tobacco closer on the tier poles in order to preserve the moisture. If the atmospheric conditions are such that a high heat and moisture can be maintained at the same time for a considerable period, material darkening of the tobacco will result. It may be well to remember, however, that tobacco once darkened can not be lightened again, and also that it is possible for the manufacturer to take tobacco and darken it to meet the demands of the trade. Therefore it seems advisable for the grower to cure his tobacco a good, rich, solid cherry-red color, which meets the requirements of a larger trade and consequently invites competition among the buyers, this class of leaf being acceptable both for home manufacturing and export.

STRIPPING AND ASSORTING.

Nearly all the tobacco grown in the dark district of Virginia is taken down during a natural "season." "Ordering" cellars are the exception, although they are used in some instances. Tobacco will retain its order better and suffer less damage when taken down in a cool "season." It should be in sufficiently good "order" so as not to break in handling, but must not be too moist. It is in the right condition when the stem is still a little brittle close to the stalk. Tobacco, of course, comes in "order" much more readily in warm than in cold weather, and it softens very slowly, even in a saturated atmosphere when the temperature is below 50° F.; but under 40° F. it will hardly come into "order" unless continued damp weather occurs.

The stripping from the stalk and the assorting of the leaves are usually performed at a single operation. The grade forming the largest portion of the crop is not usually stripped off by the sorter, but is passed over on the stalk to those who are performing the tying, to be stripped off later. The tying is usually done by women and children.

In an average crop, reasonably uniform in size and color, about four grades are made. The poorest grade is known as sand lugs, and consists of two or three leaves from the bottom of the plant, which are thin and poor in texture. The next grade is good lugs, and consists of leaves that have little more body and slightly better texture, but are perhaps uneven in color, wormeaten, or have some other imperfection sufficient to keep them from being classed with the leaf grades. The next two grades are composed of perfect leaves of good color, body, and texture, known as long and short leaf, and in some crops it is possible to select a fifth grade, which will be suitable for plug wrappers for domestic manufacture. In the last grade the leaves must be absolutely perfect in every respect. The proportion of grades varies greatly in crops, and it is understood that a certain grade of one crop will differ from the same grade in another. This is especially true of the leaf grades. Sometimes the good lugs of one crop may really be better tobacco and bring more money on the market than the leaf grades of another crop.

An effort should be made in assorting a crop to make each grade conform as closely as possible to some specific trade requirement. For example, if there is sufficient leaf in a crop to warrant making a wrapper grade care should be taken to place in that grade only leaf that is suitable for that purpose, and so with the Austrian and Italian types and others demanded by foreign trade. The various market grades pass imperceptibly from one to another, and it is often a matter of judgment, even among experts, as to where a certain grade of leaf may be used to the best advantage. The qualifications of the higher grades of leaf are more clearly defined than are the lower grades.

MARKETING.

Practically all of the tobacco grown in the dark district of Virginia is marketed by the auction system. In all of the larger towns and cities of the district there are immense sale warehouses conducted for the display and sale of tobacco. A considerable portion of the crop is shipped to town in hogsheads by rail; but a still larger portion is marketed by packing the different grades down in the wagon body and hauling to town. By this method tobacco is often taken to markets 25 or 30 miles distant.

The auction system of selling has many advantages to recommend it, as well as some disadvantages. There are some growers who believe that they could do better by personally negotiating the sale of their tobacco as they do with their other crops. Under the existing system the market, the buyers, and the money are always at the farmer's immediate command whenever his tobacco is ready for sale. The charges and commissions for selling are uniform at the different markets and are subject to little change. If a grower is not satisfied with a price on a certain lot of his tobacco, he may pass the sale and

offer it again at another time, usually without extra warehouse charges. The laws and regulations which have been formulated as a result of many years of experience for the purpose of assuring fair dealings between the buyer, seller, and warehouseman are, in general, satisfactory. It is, however, beyond the province of this Bureau and this station to enter into a discussion for or against this system of marketing; the intention is merely to describe the system as it exists.

There is, of course, an opportunity with the auction system for the grower to look after the marketing end of his operations to advantage. It is needless to emphasize that the tobacco should be placed upon the market in the best possible condition, so that it will appear to advantage, and it is advisable for the grower to keep in close touch with the market so as to know the prevailing price of the standard grades. He will then be in a position to know whether he is receiving a fair price for his tobacco and can better judge as to the advisability of passing a sale or not.

In the foregoing account of the methods of cultivating and handling dark tobacco, the Bureau and the experiment station have attempted to explain the methods which they have found to be the best in their general experience, and as brought out in their three years' experiments. Of course no two crops would ever be handled exactly alike, and without a clear understanding of the principles involved it would be impossible intelligently to adapt methods to various conditions, seasonal and otherwise. In the experimental crops grown at Appomattox the practice has varied somewhat each year, according to conditions, but the procedure all through has been based upon the principles outlined in this bulletin.

SUMMARY.

In the dark fire-cured tobacco district of Virginia, with declining yields and low prices, little profit results to the grower.

More intensive methods of cultivation and a greater expenditure per acre for fertilizers—larger application and a better grade of fertilizer—result in increased yields per acre and in a larger proportion of the higher grades of leaf.

The increased returns from the intensively cultivated crop pay for the increased cost of labor and fertilizer and leave a larger net profit to the grower than accrues from the methods used by the generality of the growers in this district.

Intensive cultivation leaves the fields in better condition for succeeding crops in the rotation, giving increased profits from these crops.

The effect of the more intensive fertilization and cultivation was noticeable over the three years covered by this demonstration work, and the limit of improvement of the soil had apparently not been reached.

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